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GEOSCIENCE EDUCATION AND DEVELOPMENT ON THE NEEDS (OR LACK OF) OF ENVIRONMENTAL INPUT

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GEOSCIENCE EDUCATION AND DEVELOPMENT

ON THE NEEDS (OR LACK OF) OF ENVIRONMENTAL INPUT*

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ABSTRACT

Today, more than ever before, there is an increased awareness of the importance of geoscience education and its relationship to human welfare. Teaching of geoscience in most of the developing countries a fairly new innovation. The rapidly diminishing mineral and energy resources, rising populations, expanding cities and environmental problems are but a few of the problems that today's geoscientists are asked to address themselves to. It can be argued the relatively recent social, cultural and scientific changes have begun to affect the geosciences to the extent that new and more innovative approaches to geoscience education are not only desirable, but has become a necessity.

The writer here feels that more environmental inputs should be introduced in the present geoscience curriculum. The needs of these environmental inputs are cited with special examples of environmental impacts of mining industries. Ways and means of introducing these environmental inputs are also described in this presentation.

1. INTRODUCTION

At present, it can be argued that there is an increased general awareness of the importance of geoscience education in the context of human welfare. This awareness and interest shown by the general public is due to other reason than the contribution made and activities carried out by the petroleum, mining and geotechnical sectors.

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The contribution of mineral and petroleum resources as well as their respective industries for example in this region of Southeast Asia have been quite for reaching. These include the direct contributions on employment, gross domestic product, earnings in foreign exchange, transfer of technology, the prospects of affering further employment and generating power, in refining and associated industries, as well as the extent to which they are ancillary facilities to transport and power, that are capable of serving other sectors and purposes other than mining.

At present, problems such as rapidly diminishing natural resources (such as tin, coal, petroleum), environmental pollution, expanding cities and rising populations are some of the many problems that geoscientists should be of service in but few are asked to address. This paper tries to focus on the following themes (1) Basic objectives of geoscience education (2) Current trend of geoscience education (3) The needs of environmental inputs - a case with mining activities (4) Ways and mean to introduce environmental inputs.

2. BASIC OBJECTIVES OF GEOSCIENCE EDUCATION

2.1. What is Geoscience?

Geoscience can be interpreted as the study of the earth and its relationship with man and the environment. Increasing concern in the study of the earth is reflected by the many departments division or bureau of Earth Science, Geology, Geological Science in government organisation, universities and industries.

In order to find out whether there are any significant differences and similarities in the meaning of the above terms, one can refer to the Glossory of Geology (Second Edition) published by the American Geological Institute (1980). This glossary is generally accepted as the authoritative source of geoscience definitions.

The above mentioned terms has been defined as follows (American Geological Institute, edited by Bates and Jackson, 1980).

(i) Earth Science. "An all-embracing term for sciences related to the Earth (analogous, in educational parlance, to 'life science'). It is occasionally used as syn. for geology or geological sciences, but this usage is misleading because in its wider scope earth science may be considered to include such subjects as meteorology, physical oceanography, soil chemistry, and agronomy. The term is generally used in the singular."

(Bates and Jackson, 1980: 195)"

(ii) Geology. "The study of the planet Earth-the materials of which it is made, the processes that act on these materials, the products formed, and the history of the planet and its life forms since its origin. Geology considers the physical forces that act on the Earth, the chemistry of its constituent materials, and the biology of its past in habitants as revealed by fossils. Clues on the origin of the planet are sought in a study of the Moon and other extraterrestrial bodies. The knowledge thus obtained is placed in the service of man-to aid in discovery of minerals and fuels of value in the Earth's crust, to identify geologically stable sites for major structures, and to provide fore-knowledge of some of the dangers associated with the mobile forces of a dynamic Earth. See also geological Science; Earth Science geoscience; historical geology, physical geology"

(Bates and Jackson, 1980: 258)

(iii) Geological Science: "Any of the subdisciplinary specialities that are part of the science of geology eg. geophysica, geocehmistry, paleontology, petrology, etc. The term is commonly used in the plural. See also geoscience. cf., Earth Science."

(Bates and Jackson, 1980: 258)

(iv) Geoscience: "(a) A short form, sometimes used in the plural, denoting the collective disciplines of the geological sciences. The term, as such, is synonymous with geology, (b) A syn. of earth science."

(Bates and Jackson, 1980: 260)

From the above definitions, one could conclude that essentially they are generally synonymous terms and all the definitions are acceptable as the study of earth materials, earth processes, and earth history. However, although the title of this paper is geoscience, the emphasis here is geology.

2.2. Basic objectives of Geoscience Education

Having defined the descipline, one therefore ask what should be the basic objectives of geoscience education. Although there are many reasons for teaching geoscience, certain basic objectives must be considered.

According to Professor William H. Mathews III, Chairman, Commission on Teaching, International Union of Geological Sciences (IUGS), the following four are the basic or fundamental objectives of geoscience education:-

1. To prepare sufficient number of professional geoscientist to fulfill national needs.
2. To assure maintenance of professional competence through various programs of continuing education (short courses, workshops, etc.) for practicing professional geoscientists.
3. To encourage and provide more and better precollege earth science education.
4. To promote public awareness of geoscience and to emphasize its everyday importance to decision makers and the lay public.

(Mathews III, W.H. 1983 p.4)

There is no denying that not every geoscience department addresses itself to all of the above four problems. The objectives listed above apply almost equaly to the developed and developing countries. Each departments have their own goals and emphasis and they might also have different priorities. It is apparent too that in attaining these basic objectives there should be conscious efforts to educate the professional geoscientists in dealing with the environmental effects of their industries.

3. THE CURRENT TREND OR CONCERNS OF GEOSCIENCE EDUCATION

3.1. Global Perspective

Having known the basic objectives of geoscience education one therefore ask another question "How might the above goals be attained and how could they relate to the needs of the modern world?". The answer to the above question is perhaps, firstly, one must identify these universal needs and also the constraint's that are associated with meeting those needs. Secondly, although there is an urgency in the global needs, one should be aware of certain educational concerns that must be considered in educating the future geoscientists.

According to Professor William H. Mathews III, who is also the Regents' Professor of Geology, Lamar University, Beaumort, Texas, U.S.A., these concerns can be grouped into two: namely (i) global or universal concerns and (ii) educational concerns.

As regards to global or universal concerns, the following have identified:

"1. An unabated and steady increase in the world population resulting in greatly accelerated consumption of natural resources.

2. A steady decrease in the quality of the environment as nations undergo increased industrialization and attempt ot serve their increasing population.

3. A serious need for new exploration techniques as well as new technologies to develop and conserve natural resources.

4. A potential shortage of well-trained competent geoscientists and technologists to solve the problems related to population increase, environmental pollution, and natural resource shortages noted above.

(Mathews II, W.H., 1983: 5)"

The above constraints are facts of life and should be well know the geoscientists. One do not deny that there are other constraints too.

As regards to educational concerns, geoscientists have a special namely over those whom they teach as they are preparing the geoscientists the future. In the final analysis, perhaps it is not extravagant to say it it is the geoscience educator who must consider each of the above global cerns and then design and teach curricular that will produce the type of scientist best qualified to address these and similar problems. As such cational concerns are also global concerns.

The following five educational concerns are listed:

"1. First, foremost, and fundamental is funding - without adequate financial support there can be no quality in geoscience education.

2. There must be an available pool of well-prepared, dedicated and enthusiastic geoscience educators.

549 3. Geoscience curricular should be designed to produce a 'product' (the geoscience graduate) - that is acceptable and useful to the 'consumer' (the potential) employer of geoscientists).

4. These who educate geoscientists should be provided with an academic environment and physical facilities suitable for teaching.

5. There is a real need to attract larger numbers of <u>better prepared</u> and promising students into the geosciences - each <u>students</u> is the lifeblood of any viable science.

6. Graduates of Geoscience Departments should be placed in positions that will most benefit them and their nation.

(Matthews III, W.H. 1983: p.s.)*

Assuming that sufficient financial support, adequate teaching facilities and the presence of <u>better-prepared</u> students are available one can therefore argue whether there are enough competent geoscientists fraternity available and what is the best kind of curriculum that have tackle or control the many problems or environmental impacts that have been brought about by the respective industries. Finally one also must wonder whether our graduates will be misplaced at the time of declining mining activities.

3.2. <u>Present state of Geoscience Education</u>

Current studies reveal that geoscience education is continously thriving in the world's tertiary institution. According to Professor Mathews III (1983) that the developing countries are just realising its importance whereas the developed countries are now becoming reacquainted with its contributions. It is further noted that the developing countries are trying to produce their own geoscientists to develop and locate their natural resources and to assist in solving environmental problems. This new awareness or realization of its new role in the developing countries is supported by the recent 'series' of workshop on curriculum development such as in Manila in 1981. (Tan and Khoo, 1982), and recently in Chiang Mai, Thailand (Anonymous, 1983).

In U.S.A., the expansion of geoscience department has been quite notable.

> According to Professor Matthews III, "the Directory of Geoscience Departments reported 510 degree - granting departments as opposed to 407 listed in 1970. In addition, there were 175 institutions that offered geoscience two-years courses in 1982 compared to 137 in 1970. An AGI Survey revealed that there were 5,805 faculty members teaching approximately 44,500 students at the bachelors, masters, and doctoral level in 1982. But a 1970 survey reveals that there were only 4,480 of these degrees granted and geoscience faculty numbered about 4,603. (Matthews III, 1983:p.6-7)"

In Japan, there are 25 national universities which offer geology courses. All these courses are conducted within the Faculty of Science. In addition there are about 50 geoscience departments in national teachers colleges (Kuroda and Nozawa, 1983). In Korea there are 15 departments of geoscience education in the national universities and a further 10 in private universities (Bong, 1983).

In Southeast Asia, there are 2 to 5 geoscience departments in each of these countries (Table 1). Except for the University of the Philippines, all other universities were established after 1950. In Malaysia the Geology Department in the University of Malaya was established about 25 years ago in Singapore and it was then transfered to Kuala Lumpur in 1960 (Mohamad Ali Hasan, 1981; Tan, 1982). Increasing awareness of the importance of geoscience education in Malaysia is proven by two workshops organised by the Geoscientists fraternity. -The first workshop concerned basically with the geoscience curriculum organised by the Geological Society of Malaysia was held in April 1982 in Kuala Lumpur. Some 42 members and non members participated in the workshop, which comprised participants from all the universities in Malaysia, Mara Institute of Technology, Petroleum companies (such PETRONAS, ESSO, BNOC), Geological Survey Malaysia, Ministry of Education (Curriculum Centre and Examination Section) and the mining sector (MMC, SEATRAD Centre, Perangsang Selangor). Among the recommendations made were as follows:-

"1. University geology curriculum should cover more basic geology rather than specialised areas, i.e. what is needed is strength in basics and not overspecialisation at a too early stage.

2. Industries and governments sectors or future employers should provide vacation training for the students.

3. Geology curriculum should be formulated with the following views in mind:-

   a. that there would be opportunity for course-related employment.

   b. that a broad coverage of the Geoscience to B.Sc./B.Sc. Honours level is offered, and

   c. that the programme is designed so as to give maximum opportunity for independent action and includes at least one major piece of project work.

4. All curricular should be reviewed periodically and tailored to the requirements of the development of the country.

(Mohamad Ali Hasan, 1982; 61)"

The workshop further recommended that "Dewan Bahasa and Pustaka (DBP), being the 'keeper' of the National Language, Bahasa Malaysia, should publish the "ISTILAH GEOLOGI" (GEOLOGICAL TERMS in Bahasa Malaysia) and help to establish the inter university committee for geological terminology (Mohamad Ali Hasan, 1982: 62). Since this last recommendation was not taken heed of by the authority concerns, another workshop was organised by the Geological Society of Malaysia in "Use and Implementation of Bahasa Malaysia in the fields of Geoscience", this time with the cooperation of DBP. The workshop was held at DBP on 23rd April 1983. Again one of the recommendations was to urge the DBP to form a National Language Committee on Geological Terms (Jawatankuasa Pusat Istilah Geologi DBP), and finally in May this year the committee was formed with 3 representatives from Universiti Kebangsaan Malaysia, 3 from Universiti Malaya, 1 from Universiti Teknologi Malaysia, 1 from Universiti Pertanian Malaysia, 1 from Geological Survey Malaysia, 1 from Petronas and 1 from Puspati and the Secretariat from DBP.

The above has been mentioned in view of the fact in the case of Malaysia, development in geoscience education can only occur successfully if the basic requirement of the necessary 'istilah' (geological terms) is taken care of properly and permanently.

The paper however is arguing on the premises of recommendations no. 1 and 4 of the earlier workshop i.e. on what actually is being considered as basic in geoscience education? Is not the environmental inputs of great importance? This writer believes that the environmental inputs should also play an important role in educating the geoscientists. Let us now look at only the needs for environmental inputs, citing cases in mining industries. Preliminary investigations on the whereabout of graduates from the University of Malaya from 1956 to 1980 showed that they are being employed in the following sectors:- namely Petroleum sectors (32%), Geological Survey (23%), Mining sectors (10%), Higher Institutions (13%), Soil Science (5%), Engineering geology and related service (4%), teaching and commerce (6%), and the rest untraced (7%) (Mohamad Ali Hasan, 1981). According to Tan (1982) the employment opportunities for geologists (or applied geologists) in Malaysia has varied greatly over the past two decades, both in the number of geologists employed each year and in the field in which these vacancies exist. In the early sixties, the Government's Geological Survey and to a lesser extent, the Soil Survey Departments were the most important avenues for employment of geology graduates. The mining industry only started to employ local geoscience graduates in the late sixties. The demand for geologists in Malaysia increased appreciably in the late seventies when oil and gas operations made its impact on the employment opportunities for local geologists. A significant number of graduating geologists have been taken in by the establishment of more geoscience departments in Malaysian Universities (such as UKM, USM, UTM and UPM). Since employment opportunities in Malaysia are quite varied, it is therefore imperative that all future changes in the cu curriculum must retain the broad based geological training without too much specialisation.

4. WHY THE NEEDS FOR ENVIRONMENTAL INPUTS - A CASE OF MINING ACTIVITIES

The interpretation of environmental inputs (or environmental assessment is as follows:-

b. "A detailed statement prepared by an organisation for its own use to appraise the effect of a proposed project on the aggregate of social and physical conditions that influence a community or ecosystem. The assessment is often prepared to determine the need for a formal environmental impact statement.

(Bates and Jackson, 1980: 205)

The lack of environmental inputs in the mining industries can be explained by the increasing detrimental impacts that they may have caused.

4.1. Detrimental to landscapes

Wuarrying of rocks for road metals and building materials from hills will scar the landscape. Classical examples in Malaysia are the numerous limestone quarries in Kinta Valley and Batu Caves together with Bt. Gambier in Penang and Bt. Gombak in the Batu Caves area for housing projects. These scalpings of the landscape often have led to destruction of surface ecology. Worked out and abandoned quarries will create artificial cliff fares which could be an eye-sore besides being unstable and a danger to human life. The contour of the land and its physic-biological properties are also altered.

4.2. Blasting and crushing in limestone quarrying and cement making industries tend to cause vibration, excessive noise and dust pollution. Pollution problems especially from dust particles will affect the environment and human health in the surrounding areas concerned. Examples of these areas are the cement factories in Rawang, limestone quarries in Batu Caves and Datuk Kramat Smelting works in Penang (C.A.P., 1978). DOE monitoring around limestone quarry areas of Batu Caves has revealed the dust level is 5 times above the WHO standard (EPSM, 1982). In 1980, it is estimated that the quarry activities in the Batu Caves area give rise to tremendous dust pollution (at its worst, 76-6 tons of dust fall per square mile per month) threathing the health of 20,000 residents (Utusan Konsumer, 1980).

4.3. Chemical Pollution

Mining activities can also create chemical pollution. According to Edurigis and Teodula (1982), mine tailings from copper, gold, iron, chromium and zinc mines in the Philippines are the principal sources of river pollution. Nine rivers in Luzon, three in Visayas, one in Palawan and Marindugue are being polluted by this waste. Deposited downstreams in low flat lands, mine waste cause siltation and high toxicity of heavy metals, acids, alkalis and inorganic salts. Some 128,000 hectare of irrigable agricultural lands are found unproductive. Estimates of losses due to crop yield reductions alone are 32 million and 46 million for Ambarayan and Agno River Irrigation System, respectively. In a paper presented to a seminar on 'The Malaysian Environment in Crisis'. Mr. Maheswaran from the Division of Environment, Ministry of Science, Technology and Environment added,

'Further, tin mining activities are also contributing most generously to the problem, adding a high load of suspended silts and significantly affecting the quality of water at water supply at intake points (Maheswaran, 1982: 130).

4.4. Excavated or removal of materials

Mining activities has resulted in the removal or excavation of material materials. According to Goudie (1981), the world's largest excavation is the Birgham Canyon Copper Mine in Utah, USA. It has involved the removal of 3,355 million tonnes over an area of 7.21 km^2 to a depth of 774 m, seven times the amount of material moved to build the Panama Canal. In Malaysia, over 200,000 hectares of badly degenerated tin tailings exist on land which represent some of the best agricultural areas in the country (Maene, 1981). According to Tan (1982) extensive tin mining in the Kinta and Klang Va-leys since the last century have resulted in vast stretches of 'westeland' that now pose serious problems to other forms of landuse, in particular to urban construction or housing schemes. Tin tailings also pose great problems to the construction industry. They are problem soils for the civil or geotechnical engineers because of low bearing capacity, large settlement of structures, etc.

4.5. Accelerated Sedimentation

An inevitable consequence of the accelerated erosion produce by man has been accelerated sedimentation. This has been heightened by a deliberate addition of sediments to stream channels as a result of the need to get rid of mining and other wastes. As early as 1922, the British Colonial government has introduced the silt Control Enactment for the Federated Malay States, for the purpose of preventing excessive siltation of natural water courses due to mining activities (Goh, 1982).

In Peninsular Malaysia, according to Abu Bakar and Hasman (1978), the major polutants identified related to tin mining activities are silts, inorganic dissolved solids/suspended solids and organics (overburden). The main pathway of the major polutants identified was through overflow from tailing ponds. Research is still needed on the inpact of mining on the water table within the vicinity. 'Frequent complaints from villagers in the vicinity of mines, however do require some explanation for the drying up of their wells (Abu Bakar and Hasmah, 1978: 107)' In the Philippines, the improper disposal of mining wastes has contributed significantly to the serious sedimentation of streams, reservoirs and valuable agricultural lands (Saplaco, et.al., 1974).

4.6. Accelerated Coastal Erosion

Further, mining activities can cause accelerated coastal erosion. One of the best forms of coastal protection is a good beach. However, increasingly sand and gravels have been removed to provide aggregates for construction purposes. In Indonesia, Brotodihardjo (1982) witnessed how the exploitation of sands, gravels and pebbles on the coastal regions of Vara, have given rise to bad influences on the river environment. In Peninsular Malaysia, main source areas of extraction of sand and gravel are the rivers and the tin mining areas. Extraction of sand/gravel from the rivers is done either by manually or mechanically scooping or pumping it from the river banks or beds (Aw, 1982).

4.7. Ground Subsidence

The removal of solids in underground mining, the transfer of subterranean fluids (such as oil, gas, air, water), dissolving solids and removing them in solutions (e.g. sulphur and salt) can cause ground subsidence. Some of the most dangerous and dramatic collapses have occurred in limestone areas because of the devastation of limestone caused by mining activities (Gondie, 1981). In Malaysia, according to Tan (1983), ground subsidence related to mining activities in the Kinta and Klang Valleys consist of two types which are attributed to two different causes:- (1) due to the general lowering of ground water table especially when near a mine pit or center, and (2) due to the sudden collapse over sinkholes.

The lowering of ground water table use to mining activities causes consolidation of the clays in the areas affected, and thus settlement of the ground surface. The effect is greatest in the immediate vicinities of mine pits. Examples of this effect that have been reported are in the Serdang Lama and Jinjang (in Klang Valley) and also in Batu Gajah and Kampar (in Kinta Valley). In the case of the sudden collapse into sinkholes, numerous reports have been made in the past and also recently, sometimes involving buildings and man that suddenly sink into these holes. It is conceivable that the extensive mining in the Kinta and Klang Valleys have accelerated or triggered off the development and sudden collapse of sinkholes in recent years. The report in February 1982 of the sudden appearance of three large sinkholes whithin a period of several days only in Kg. Merah (Kinta Valley) highlights the severity of the sinkhole developed on some parts of Kuala Lumpur - Seremban highway.

In a detailed study of the impact of salt mining and refining in the northeast of Thailand, Rau, Nutalaya and Boonserer (1982) found out that the areas of subsidence range from $20m^2$ and the maximum depth ranges from 1.9 to 6m. The depth of the salt bed is unknown but is presumed to be about 25-30m, which is the depth of most of the salt walls in the area.

A more widespread problem is possed by groundwater abstraction for industrial, domestic and agricultural purposes (Goudie, 1981). For further reports of ground subsidence due to groundwater abstraction the writer suggest reference be made to Mohamad Ali Hasan (1983) for a general over-view of these problems and other ill effects of petroleum development.

4.8. Accidents: Loss of life as well as belongings

Mine landslips and landslides are not uncommon in both the Kinta and Klang Valleys in Malaysia. In Perak (Kinta Valley) landslips at mining areas between September 1971 and November 1976 killed 29 people and injured many others. Rockfall, mine pit cared in and mining pool bund collapses have killed 59 people between 1973 and 1974 in Malaysia. At Puchong (Selangor) landslide in a tin mine area have killed 31 people (EPSM, 1982).

To sum up, environmental impacts of mineral resources exploitation can be summarised as that of a work done by Roy (1982) in Dehru Dun - Mun - soone Area X, India.

> '... that exploitation of the minerals creates derelict landscape along the hill slopes and the disposal of the mine waste is largely responsible for the stream siltation. In addition to these, mining is also for pollution and contamination of the stream water, noise and dust pollution, scaring away of the wildlife, depletion of groundwater and dislocation of the local population. Large scale mining also largely responsible for shrinking forest reserves and areas of the cultivable land.
>
> (Roy, 1982: B14.5)'

An attempt to generalise various human impacts of mining activities are shown in Table 2. In addition to written descriptions and analysis of the various and complex human impacts on the country, it is convenient for many purposes to have a chart setting them out schematically so that each can readily be identified and compared with others (Nicholson 1972, Mohamad Ali Hasan 1983).

5. HOW TO INTRODUCE THE ENVIRONMENTAL INPUTS

There really is only one way that can be envisaged, i.e. the introduction of environmentally related disciplines or courses in the teaching curriculum or through informal education by way of seminars, conferences, workshops etc.

5.1. Formal - this is through formal education at the primary, secondary and tertiary levels, as demonstrated below (Table 3).

In comparing the geology courses offered in both the universities (UKM and UM) as shown in Table 4, there seems to be much desire to introduce courses leading to conservation and wise management of natural resources. The personal feeling is that the present course structure is teaching the students the art (or scientific skill) in exploring, exploiting but not conservation. Courses in environmental geology, geological Conservation and Resources Policy and Management of Natural Resources should be introduced and taught in geology curriculum. Alternatively, if the above mentioned courses are not to be introduced, lectures on environmental impacts (and also socio-economic impacts) and conservation measures should be given in the present courses such as Economic Geology, Petroleum Geology, Engineering Geology and Hydrogeology/Groundwater Hydrology.

5.2. Informal

Informal education (including refresher courses or in-service training) to expose the future employees of the mining sectors to the better management of mining of industries is needed (such as EIA, laws related to mineral resources and environment, technical solutions to the minimise environmental impacts).

Private organisations (NGOs) such as CAP, SAM, etc can and have shown to have influenced the mass media and this is the best means of educating the public. Forums, seminars, documentary films, etc. can be a sample of their

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activities in relation to the mining issue. Once the public is aware than it would be not too difficult (we hope) for the politicians to do something in parliment in creating the necessary laws.

Mass media should be encouraged more articles on environmental issues due to mining and quarrying activities. Such exposures perhaps can convince the mining industries to 'reconsider' all their operation in such away as to minimise any unwanted impacts to the public.

6. CONCLUSION

In this paper I have attempted to highlight the current trends of geoscience curriculum and the needs to introduce more environmental inputs in the present geoscience curriculum in Malaysia. The needs for these environmental inputs are cited with special examples of environmental impacts of mining industries. Ways and means of introducing these environmental inputs either through curriculum modifications or informal education are also described.

It appears that widespread concern for the mineral resources and the demand for corrective action is a recent phenomenon in most developing countries. There is much to be derived in educating the future geologists not only to explore and exploit but also to conserve. Awareness of the needs to conserve will lead to better development of the natural resources for the nation. It is not enough just to provide scientific and technological know how to future geologists but an awareness of the ill effects of the methods used in development of these natural resources must also be created, so that the effects are minimised or controlled.

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Table 1: GEOSCIENCE EDUCATION IN SOUTHEAST ASIA

Country	No. of Geoscience Depts.	Name of Universities (Year established)	Source
Indonesia	5	i) ITB (1950) ii) U. Gajah Mada (1959) iii) U. Padjadjaran (1959) iv) U. Pembangunan Nasional (1970) v) U. Trisakti-private (1980's)	Atmadjap (1983)
The Philippines	3	i) University of the Philippines (1914) ii) Mapua Inst. of Technology (?)* iii) ADAMSON University(?)* (*private)	Sonido (1983)
Thailand	5	i) U. Chulalongkorn (1958) ii) U. Chiang Mai (1964) iii) U. Khon Kaen (1977) iv) Prince Songkhla U. (1981) - Earth Sc. v) Kasetsart U. (1982)	Kaewbaidhoon and Tantisukrit (1983)
Socialist Republic of Vietnam	3	i) Hanoi Politechnic Institute (1966) ii) Hanoi State U. (?) iii) Ho Chi Minh U. (?)	Xinh and Chu (1983)
Singapore	Nil	(No geology dept, however geog. and civil engineering courses are available)*	Wong (1983)
Burma	1	i) Arts & Sc. University, (?)	Tan & Khoo (1982)
Papua New Guinea		i) Univ. Papua New Guinea (?)	Tan & Khoo (1982)
Malaysia	2 (+3)	i) Universiti Malaya (1960) - K.L.* ii) Univ. Kebangsaan Malaysia (1970) iii) Univ. Sains Malaysia - Geophysics (1972) iv) Univ. Teknologi Malaysia - petr. geology (1972) v) Univ. Pertanian Malaysia - Soil Sc. (1973)	Ismail Mohd. Noor (1983), Tan (1982) Yan (1982) Abdul Aziz Hussin (1983)

(* Univ. Malaya Singapore 1958)

Table 2: Chart of Environmental Impacts of Mineral Exploitation and Development (excluding groundwater)

(Modified after Nicholson, 1972, Mohamad Ali Hasan, 1983)

(A) ACTIVITY OR OPERATION	(B) Nature of Effects Arising	(C) Area or Land-type Affected	(D) Incidence (Time, Space, Degree)
1. Sand gravel extraction.	Beach and bank erosion; pollution of rivers by gravel washing; spillage during disturbance and destruction of surface ecology, physiography and archeology.	Many coastal, river valley and ex-mining lands (tin) (Eg. Kinta and Klang Valley)	Suitable areas intensively worked for a period of years when worked out and operations abandoned new problems of use or restoration arise.
2. Brick clay and brick making.	Creates large spoil heaps; disturbance and destruction of surface ecology, physiography and archeology.	Superficial clay deposits.	Localised.
3. Road metal and building.	Destruction of surface ecology; detrimental to landscape. Worked out quarries create artifical cliff faces and pools. Rockfall, Landslides.	Areas geologically suitable with bed-rock near surface.	Fairly general
4. Limestone quarrying and cement making.	Destruction of surface ecology and of cave systems, atmospheric pollution. Pollution and diversion of underground water supplies. Detrimental to landscape; downland vegetation covered with dust; mine pit covered in; rockfall.	Limestone areas. (Eg. Kinta and Klang Valley)	Localised in a number of widely scattered areas.
5. Opencast coal mining.	Disruption of drainage; damage to amenities, detrimental to landscapte; air pollution.	Areas where coal deposits close to surface.	Locally intense in limited areas for limited periods.
6. Underground coal mining and coal generation electricity supply.	Detrimental to landscapte. Air pollution notably sulphur dioxide; subsidence; warming of water; spoil heaps above ground level.	Areas mainly underlain by major coal deposits.	Limited but dominant where it occurs.

(A) ACTIVITY OR OPERATION	(B) Nature of Effects Arising	(C) Area or Land-type Affected	(D) Incidence (Time, Space, Degree)
7. Underground mining for lead.	River pollution by lead residues leaching out of disturbed spoil heaps around old lead mines may destroy all fish and most other aquatic wildlife.	Areas mainly underlain by major lead deposits.	Localised.
8. Underground mining for salt.	Creation of inland saline habitats, subsidence.	Areas of salt deposits.	Localised.
9. Open cast tin mining (and gravel pump tin mining)	Detriment to landscape; removal of materials, accelerated sedimentation, chemical pollution; mining land-slip and landslides, mining pool collapsed; ground subsidence.	Areas of tin deposits (Eg. Kinta and Klang Valley)	localised in a number of widely scattered areas.
10. Copper mining excavation.	Detriment to landscape; removal of materials; accelerated sedimentation, Chemical pollution.	Areas mainly underlain by major copper deposits. (Eg. Mamut Copper Mine, Sabah).	Localised in a number of widely scattered areas.

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Table 3: Environmental Inputs through formal Education.

	Levels	Means	Examples
1.	Schools (primary, secondary & vocational)	Curriculum (eg. man & environment)	Field trips; visit to disaster areas
2.	Universities/colleges	Curriculum, seminars, workshop, conf. (eg. Environmental Geology)	Field trips, visit to disaster areas; appropriate technology
3.	Government (and private) organisations	Advice, services, research, seminars, workshops.	EIA, appropriate technology
4.	Law Enforcement	Bills in parliament (Env. Quality Act 1974) and various regulations	Mining regulations comparable to that of Crude Palm Oil, Clean Air, Natural Rubber, etc?

Table 4: GEOLOGY CURRICULUM AT (A) THE UNIVERSITY OF MALAYA (After Tan, 1982)

UNIVERSITY OF MALAYA (UM) (After Tan, 1982)

Year I

Introduction to Geology (2 units)
Introduction to Geological Maps
Introduction to Minerals, Rocks and Fossils

Year II

Mineralogy I
Invertebrate Paleontology
Structural Geology I
History of the Earth (2 units) (For students not taking Geology, Applied Geology in Year III)

Year III

(A) Geology Course Package

Stratigraphy I
Sedimentology I
Igneous Petrology I
Geochemistry I
Solid Earth Geophysics
Tectonics
Economic Geology
Geological Field Methods
Analytical Geochemistry
Metamorphic Petrology
Photogeology & Geomorphology
Sedimentology II
Igneous Petrography
Structural Geology II

and TWO from following:-

Micropaleontology
Mineralogy II
Exploration Geophysics
Stratigraphy II

(B) Applied Geology Course Package

Stratigraphy I
Sedimentology I
Igneous Petrology I
Geochemistry I
Solid Earth Geophysics
Tectonics
Economic Geology
Geological Field Methods
Analytical Geochemistry
Metamorphic Petrology
Photogeology & Geomorphology
Sedimentology II
Igneous Petrography
Structural Geology II

and TWO from the following:-

Applied Geophysics I (units)
An Introduction to Soils & Soil Mechanics
An Introduction to Groundwater Hydrology

Year IV

(A) Geology Course Package

Geology of Malaysia (2 units)
Geology of S.E.Asia
Geology Seminar
Geological Concepts

(B) Applied Geology Course Package

Geology of Malaysia (2 units)
Geology of S.E.Asia
Geology Seminar
Applied Geophysics II (2 units)

(Contd) (Table 4)

(UM)

Year IV

(A) Geology Course Package

Project Reports A (5 units)

and SIX from the following:-

Micropaleontology (if not already taken in Year III)
Mineralogy II (" " " " " " ")
Stratigraphy II (" " " " " " ")
Geochemistry II
Economic Geology II
Petroleum Geology
Engineering Geology
Ore Mineralogy & Petrology (2 units)
Application of Radioactivity Nuclear
  Techniques in the Earth Science
Interpretation of Sediments and
  Sedimentary Rocks
Structural Geology III
Igneous Petrology II
Advanced Paleontology
Biostratigraphy & Palaecology
Mine Evaluation
An Introduction to Soils & Soil Mechanics
An Introduction to Groundwater Hydrology

(B.Sc/B.Sc. Honours in Geology)

(B) Applied Geology Course Package

Geological Concepts
Project Report B (5 units)

Students who did not take the following in Year III m[...]
take in Year IV:
Applied Geophysics I (2 units)

and FOUR (or TWO, if taking Applied Geophysics I) from th[...]
following:-
Micropaleontology
Mineralogy II
Geochemistry II
Economic Geology II
Petroleum Geology
Exploration Geochemistry
Engineering Geology
Ore Mineralogy & Petrology (2 units)
Application of Radioactivity and Nuclear Techniques
  in the Earth Sc.
Interpretation of Sediments & Sedimentary Rocks
Structural Geology II
Igneous Petrology II
Metamorphic Petrology
Mine Evaluation
An Introd. to Soils & Soil Mechanics
An Introd. to Groundwater Hydrology

(B.Sc/B.Sc Honours in Applied Geology)

Table 4: GEOLOGY CURRICULUM AT (B) UNIVERSITI KEBANGSAAN MALAYSIA
(After Syed Sheikh Almashoor and Ismail Mohd Noor, 1982)

UNIVERSITI KEBANGSAAN MALAYSIA (UKM)

Year I

Introduction
Optical Mineralogy
Petrography
Stratigraphy

Year II

Paleontology
Geomorphology
Structural Geology
Sedimentology
Petrology
Geochemistry
Geophysics

Year III

(i) Basic Courses

Basic Geological Mapping
Aerial Photograph Interpretation
Geology of Malaysia I
Seminar
Field Trip: North-West Peninsula
Geology of Malaysia II
Interpretation of Topographic Maps
Writing Geologic Reports

(ii) Elective Courses

Instrumental Methods
Gemology
Historical Geology
Geostatistics and Computer Applications
Physics of the Earth
Soil Science

(iii) Specialised Courses

(A) MINING GEOLOGY

Economic Geology
Ore Microscopy
Mine Evaluation
Geochemical Solutions
Ore Deposits
Applied Geochemistry
Applied Geophysics

(B) PETROLEUM GEOLOGY

Petroleum Geology
Subsurface Geology
Micropaleontology
Sedimentary Environments
Applied Geophysics

(C) ENGINEERING GEOLOGY

Engineering Geology
Rock Mechanics
Soil Mechanics
Hydrogeology
Geomechanics
Site Selection
Stabilization Earth Materials
Engineering Geophysics

(Can Opt to graduate with a general degree
or to proceed to the fourth year
or qualify for B.Sc. with Honours degree)

(Contd) (Table 4) (UKM)

Year IV

(i) Basic Courses

Seminar
Field Course
(Supervised geological mapping of an area)
Project on special topic

(ii) Elective Courses

Igneous Petrology
Metamorphic Petrology
Regional Geology
Geotectonics
Geomorphometry
Thermodynamics in Geology

(B.Sc. Honours in Geology)

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